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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/772,736 | 02/05/2004 | Juan-Jann Jou | 24061.80 (TSMC2003-0343) | 5636 |

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| EXAMINER | |
|---|---|
| BLUM, DAVID S | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2813 | |

DATE MAILED: 02/28/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/772,736 | JOU ET AL. | |
| | Examiner | Art Unit | |
| | David S. Blum | 2813 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *17 October 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-51* is/are pending in the application.

4a) Of the above claim(s) *1-26* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *27-51* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) *1-51* are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *05 February 2004* is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *5/27/04*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

This is in response to the election filed 10/17/05.

## DETAILED ACTION

### *Election/Restrictions*

Applicant's election without traverse of claims 27-51 in the paper filed 10/17/05 is acknowledged.

1. Claims 1-26 withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in the reply filed on 10/17/06.

2. Applicant's election with traverse of claims 27-51 in the reply filed on 10/17/06 is acknowledged. The traversal is on the ground(s) that the embodiments delineated by the Examiner are not patently distinct and therefore constitute a single invention. This is not found persuasive because the two inventions are product and process, and as recited in the restriction requirement, the device of claims 27-51 need not be made by the process of claims 1-26.

The requirement is still deemed proper and is therefore made FINAL.

It is noted that the listing of claims includes claims 1-26, yet at the end of the listing, the applicant has stated that claims 1-26 are canceled. In the interest of compact

prosecution, the examiner is considering claims 1-26 as withdrawn. The applicant is requested to correct the conflict.

***Claim Rejections - 35 USC § 112***

Claims 33-35 and 37-38 as well as 47-48 and 50-51 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claim 27 limits the interface between the first and second conductive layers to be substantially curvilinear whereas claim **34** limits the same interface to a substantially W-shape. The instant application (paragraph 0024) discloses that these are alternate profiles. The profile can not be alternate shapes at the same time.

Claim 27 limits the interface between the first and second conductive layers to be substantially curvilinear whereas claims **34-35 and 37** limit the same interface having a peak to which the instant application (paragraph 0024) indicates are of the substantially other undulating or W-shape. The instant application (paragraph 0024) discloses that these are alternate profiles. The profile can not be alternate shapes at the same time.

Claim 27 limits the interface between the first and second conductive layers to be substantially curvilinear whereas claim **38** limits the same interface to a substantially trapezoidal shape. The instant application (paragraph 0024) discloses that these are alternate profiles. The profile can not be alternate shapes at the same time.

Claim 41 limits the interface between the first and second conductive layers to be substantially curvilinear whereas claim **47** limits the same interface to a substantially W-shape. The instant application (paragraph 0024) discloses that these are alternate profiles. The profile can not be alternate shapes at the same time.

Claim 41 limits the interface between the first and second conductive layers to be substantially curvilinear whereas claims **48 and 50** limit the same interface having a peak to which the instant application (paragraph 0024) indicates are of the substantially undulating or W-shape. The instant application (paragraph 0024) discloses that these are alternate profiles. The profile can not be alternate shapes at the same time.

Claim 41 limits the interface between the first and second conductive layers to be substantially curvilinear whereas claim **51** limits the same interface to a substantially trapezoidal shape. The instant application (paragraph 0024) discloses that these are alternate profiles. The profile can not be alternate shapes at the same time.

### *Claim Rejections - 35 USC § 102*

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 27, 36, 39-41, and 49 are rejected under 35 U.S.C. 102(b) as being anticipated by Trivedi (US006893957B2).

Trivedi teaches the device of claims 27, 36, 39-41, and 49 as follows.

Regarding claim 27, Trivedi teaches a first conductive layer 60, a dielectric layer (parts of42) overlying the first conductive layer and having an opening extending to the first conductive layer, a second conductive layer (70) located in the opening and contacting the first conductive layer, wherein the interface between the first and second conductive layer is curvilinear (figure 6). The examiner notes that ILD 42 represents two separate dielectric layers (column 4 lines 52-55).

Regarding claim 36, the interface profile is substantially concave relative to the substrate (figure 6).

Regarding claim 39, the opening is one of a via hole or a dual damascene opening (column 3 line 57 and column 4 line 51).

Regarding claim 40, at least one of the conductive layers is copper or copper alloy (Trivedi teaches aluminum by example, but also teaches copper is used in such contacts (column 1 lines 41-43 and column 5 lines 27-29).

Regarding claim 41, Trivedi teaches the invention is applicable toward ICs, thus a plurality of semiconductor devices are coupled to a substrate, and an interconnect structure coupling devices (column 1 lines 15-23), and a first conductive layer 60, a dielectric layer (parts of42) overlying the first conductive layer and having an opening

extending to the first conductive layer, a second conductive layer (70) located in the opening and contacting the first conductive layer, wherein the (each) interface between the first and second conductive layer is curvilinear (figure 6).

Regarding claim 49, the interface profile is substantially concave relative to the substrate (figure 6).

***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 28-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Trivedi (US006893957B2).

Trivedi teaches the device of claims 28-29 as recited above in regard to claims 27 and 41, except for exact dimensions.

Regarding claim 28, Trivedi teaches the thickness of the second conductive layer to be 4000 angstroms (column 7 line 26) before removing to the plane of the top dielectric.

Although not teaching the depth of the profile, this suggests a depth of more than 200 angstroms.

Regarding claim 29, Trivedi does not teach a profile depth between 300-800 angstroms, the dimensions of Trivedi suggesting a larger scale device. However, the examiner considers the ranges to be one of optimization.

These ranges are considered to involve routine optimization while it has been held to be within the level of ordinary skill in the art. As noted in In re Aller (105 USPQ233), the selection of reaction parameters such as temperature and concentration would have been obvious:

> "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art. Such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."
> In re Aller 105 USPQ233, 255 (CCPA 1955). See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

One skilled in the requisite art at the time of the invention would have used any ranges or exact figures suitable to the device of an interconnect structure regarding dimensions using prior knowledge, experimentation, and observation with the apparatus used in

order to optimize the process and produce the interconnect structure desired to the parameters desired.

Regarding claim 30, Trivedi does not teach a profile depth between 200-700 angstroms, the dimensions of Trivedi suggesting a larger scale device. However, the examiner considers the ranges to be one of optimization as recited above in regard to claim 29.

Regarding claim 42, Trivedi teaches the thickness of the second conductive layer to be 4000 angstroms (column 7 line 26) before removing to the plane of the top dielectric. Although not teaching the depth of the profile, this suggests a depth of more than 200 angstroms.

Regarding claim 43, Trivedi does not teach a profile depth between 300-800 angstroms, the dimensions of Trivedi suggesting a larger scale device. However, the examiner considers the ranges to be one of optimization as recited above in regard to claim 29.

Regarding claim 44, Trivedi does not teach a profile depth between 500-700 angstroms, the dimensions of Trivedi suggesting a larger scale device. However, the examiner considers the ranges to be one of optimization as recited above in regard to claim 29 as recited above in regard to claim 29.

One skilled in the requisite art at the time of the invention would have used any ranges or exact figures suitable to the device of an interconnect structure regarding dimensions using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the interconnect structure desired to the parameters desired.

3. Claims 31-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Trivedi (US006893957B2) in view of Wolf (page 684).

Trivedi teaches the device of claims 31-32 as recited above in regard to claims 27 and 41, except for the inclusion of a barrier layer.

Regarding claim 31, Trivedi is silent as to barrier layers. Wolf teaches barrier layers (etch stop layers of SiN) between dielectric and conductive layers (multi-layer films may contain multiple barrier layers to protect lower layers during etching and to act as an etch stop.

Regarding claim 32, it is obvious to one skilled in the art that a film of SiN over another layer will conform to the profile of the underlying layer.

Regarding claim 45, Trivedi is silent as to barrier layers. Wolf teaches barrier layers (etch stop layers of SiN) between dielectric and conductive layers (multi-layer films may

contain multiple barrier layers to protect lower layers during etching and to act as an etch stop.

Regarding claim 46, Trivedi is silent as to barrier layers. Wolf teaches barrier layers (etch stop layers of SiN) between dielectric and conductive layers (multi-layer films may contain multiple barrier layers to protect lower layers during etching and to act as an etch stop. Thus the layer would one of the plurality of first conductive layers and a corresponding second conductive layer.

It would be obvious to one skilled in the requisite art at the time of the invention to modify Trivedi by including (multiple) barrier layers as taught by Wolf to protect lower layers during etching and to act as an etch stop.

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to David S. Blum whose telephone number is (571)-272-1687) and e-mail address is David.blum@USPTO.gov .

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr., can be reached at (571)-272-1702. Our facsimile number all patent correspondence to be entered into an application is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

David S. Blum

February 21, 2006